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**Vladislav KŘIVDA\*****NEW FINDINGS IN THE SPHERE OF THE CONFLICT SITUATIONS ANALYSIS  
ON THE CZECH REPUBLIC ROAD TRAFFIC****NOVÉ POZNATKY V OBLASTI SLEDOVÁNÍ KONFLIKTNÍCH SITUACÍ  
V SILNIČNÍM PROVOZU V ČESKÉ REPUBLICE****Abstract**

The paper surveys the history and progression of the conflict situations monitoring of the road traffic. It reflects upon our rich experience of monitoring and analysis of the participants' behavior in the road traffic by video technology within the activities of the Laboratory of Road Transport (Institute of Transport, Faculty of Mechanical Engineering, VŠB-Technical University of Ostrava, Czech Republic).

**Abstrakt**

Předkládaný článek mapuje historii a vývoj metody sledování konfliktních situací v silničním provozu. Je založen na mnohaleté zkušenosti v oblasti sledování a hodnocení chování účastníků v silničním provozu pomocí videoaparatury v rámci činnosti Laboratoře silniční dopravy (Institut dopravy, Fakulta strojní, VŠB-Technická univerzita Ostrava).

**1 INTRODUCTION**

Road safety is one of the topical problems in the modern community. Traffic accidents provoke lively discussions day. Unfortunately the dangerous places in road traffic are often paid attention to after an accident has taken place. It's important to realize, that this situations result in human as well as economic loss.

It is very important to place emphasis on the prevention of traffic accidents. Seemingly little hidden elements need to be removed. Traffic designer can never consider his traffic solution as absolutely safe and convenient. Adherence to the conflict situation analysis methodology can improve traffic solution usability.

The staff of the Laboratory of Road Transport (Institute of Transport, Faculty of Mechanical Engineering, VŠB-Technical University of Ostrava – see [www.id.vsb.cz/lst](http://www.id.vsb.cz/lst)) has dealt with monitoring and classification problems of the road traffic participants for many years. This paper deals with some experiences and results.

**2 THE HISTORY OF THE CONFLICT SITUATIONS ANALYSIS**

How is the term Conflict situation defined? This is such a moment and situation in road traffic, when some danger arises (or can arise) for some participants. The conflict situation predates every traffic accident.

The first mention of the conflict situations monitoring [1] dates back to the 1960s. In the year 1968 S. R. Perkins and J. J. Harris (General Motors) developed the method of the conflict situations monitoring on intersections. Situations on intersection entries have been visually observed and recorded, especially situations when a car had to brake suddenly or the car went off the track. This situation was called “near-accidents”, i.e. the situations, when the result was not a crash of the par-

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ticipants. In the 1970s Bennet, Baker, Hayward, Rustam and Sabey were also engaged in this methodology.

In 1972 Jan Folprecht (inspired by this methodology) developed his own methodology of the conflict situations monitoring (at that time Institute of road and urban transport, nowadays Laboratory of Road Transport, Institute of Transport, Faculty of Mechanical Engineering, VŠB-Technical University of Ostrava). He described three levels of the conflict situation seriousness:

- ❑ the 1<sup>st</sup> level – potential conflict situations, i.e. situations with only one participant of road traffic (without attendance of other participants),
- ❑ the 2<sup>nd</sup> level – situations, when the road traffic fluidity was affected, reaction of other participants is possible
- ❑ the 3<sup>rd</sup> level – situations, when only forced evasive reaction (very hard braking or sudden swing off the track) prevents crash.

The other situations (marked either as 4<sup>th</sup> level of seriousness) are traffic accidents.

### 3 FOLPRECHT'S VIDEO-ANALYSIS OF CONFLICT SITUATIONS

Folprecht started to mark monitored conflict situations by three-letter classification. Symbols are a combination of a number (it indicates the participants of conflict situation), letter or letters (how the conflict situation emergency arose) and again one number (seriousness of the conflict situation).

The first part of the three-letter classification includes the following categories [1]:

- 1 ... pedestrian,
- 2 ... car,
- 3 ... tram,
- 4 ... pedestrian x car,
- 5 ... pedestrian x tram,
- 6 ... car x car,
- 7 ... car x tram,
- 8 ... tram x tram,
- 9 ... other (cyclist, ...).

The second part of the three-letter classification includes one or more letters (source of the conflict situation). This part is always under development, can be modified. For example:

- B ... the possibility of head-up collision,
- D ... the possibility of running into from behind,
- č ... entry against the red light,
- ch ... pedestrian's guilt,
- v ... car driver's guilt.

The third part of the three-letter classification symbol describes the seriousness of conflict situation, i.e. number 1 – 3 or 4 (see above).

We can show the example of three-letter classification symbol: 4v2, which describes a conflict situation between a pedestrian and a car (number 4), which was caused by the car driver (letter v) and which did not cause the driver to have an extraordinary reaction (number 2).

The procedure of the conflict situations monitoring and analyzing by Folprecht's video-analysis has been divided into the three following steps [1]:

1. Video-recording of a chosen area from the highest place. It's acceptable to use the time mark (for better orientation during follow-up work) and audio-recording (verbal commentary of video-recording). Recommended time for acceptable recorded statistic file is one hour.
2. It is recommended that the evaluation is carried out by a group of observers due to the fact the processing becomes quicker and its results are more objective. Maximal observing time is 3 hours. The record can be stopped, slowed down and repeated.

3. The last step is the analysis of the realized data and final conclusions. We can add final numbers of individual conflict situations (within their categories) and relate their frequencies to the volumes individual (or all) traffic flows. The conflict situations can be sketched in the ground plan of monitored locality (see pictures below) can be sketched in. Then we can generate possible modifications.

Folprecht used so-called coefficient of relative confliction  $k_R$ , which gives a notion of the traffic dangerousness in the monitored locality. Coefficient  $k_R$ , indicates the number of conflict situations for 100 vehicles (or 100 pedestrians):

$$k_R = \frac{P_{KS}}{I} \cdot 100 \text{ [CS/100 u.v.]} \quad (1)$$

$P_{KS}$  – number of conflict situations (CS) per hour (only conflict situation between two or more participants) [CS/h]

$I$  – volume in unit vehicles per hour [u.v./h]

The usage and the contribution of Folprecht's conflict situations video-analysis is self-evident. We can transfer a real traffic situation from the road to a quiet traffic engineer's office and there we can analyze data collectively and also repeatedly. Disturbing influences of the road traffic (noise, dust, emissions, vibration, volume of traffic etc.) and weather (temperature, wind, rain etc.) are eliminated. Other basic characteristics of road traffic in a monitored place (volume and structure of traffic flow etc.) can also be identified from video-record.

#### 4 NEW VIEWS FOR THE CONFLICT SITUATION CLASSIFICATION

Since 1998 Folprecht's conflict situations video-analysis has been used by the Laboratory of Road Transport for the monitoring and analyzing of the road traffic participants behavior. This methodology naturally required an innovation (for example [2]).

Most of the observations have been done on the different types of intersections.

Firstly we must differentiate between conflict situations which were caused by traffic on the monitored intersection and conflict situations which were caused by a traffic situation in vicinity. We have used the following classification:

- "own" conflict situation – a conflict situation, which was caused by a traffic on the monitored intersection, (by its construction etc.),
- "non-own" conflict situation – conflict situation, which was caused by a traffic situation in the vicinity (for example other intersection etc.).

A lot of the conflict situations were evoked by other conflict situations (with different character). Then the conflict situations have been subsequently classified:

- primary conflict situations – the conflict situations not evoked by another situation,
- secondary conflict situation – the conflict situations evoked by another situation (often by primary or other secondary conflict situation).

The coefficient of relative confliction  $k_R$  was also changed, because we must include the seriousness of the conflict situations. Consequently the coefficient of weighted relative confliction  $k_{RV}$  has been instituted (for concrete type of conflict situation):

$$k_{RV} = \frac{P_{KS} \cdot K_Z}{I} \cdot 100 \text{ [CS / 100 u.v.]} \quad (2)$$

where  $K_Z$  – coefficient of conflict situation seriousness, i.e. for example:

- seriousness of conflict situation of level 1 ...  $K_Z = 1$ ,
- seriousness of conflict situation of level 2 ...  $K_Z = 3$ ,
- seriousness of conflict situation of level 3 ...  $K_Z = 6$ ,

and for all types of conflict situations:

$$k_{RV} = \frac{\sum_{i=1}^n P_{KSi} \cdot K_{Zj}}{I} \cdot 100 = \frac{P_{KS1} \cdot K_{Zj} + P_{KS2} \cdot K_{Zj} + \dots + P_{KS_n} \cdot K_{Zj}}{I} \cdot 100 \text{ [CS / 100 u.v.]} \quad (3)$$

where  $i$  number of conflict situation of the same type ( $i = 1, 2, \dots, n$ )  
 $j$  seriousness of conflict situation ( $j = 1$  or  $2$  or  $3$ )  
 $(K_{Z1} = 1, K_{Z2} = 3, K_{Z3} = 6 - \text{see above})$

## 5 THE DYNAMIC METHOD OF THE CONFLICT SITUATIONS MONITORING

The next innovation of Folprecht's video-analysis meant the transformation from the "static" to the "dynamic" method (in 2007, authors J. Folprecht, M. Blatoň, V. Křivda). It was necessary to realize that conflict situations do not happen in relatively small spaces (for example intersection, pedestrian crossing etc.), but also in the real road traffic (for example on road in rural area). The whole situation takes place in the bigger place or in a longer time period (for example during dangerous overtaking). This reality has lead to the new approach of the conflict situations monitoring using the original Folprecht's video-analysis, which was modified (see below). The measuring vehicle for dynamical measuring has been used. The vehicle was modified for the video-recording. The reason for the dynamic method is in the relations between conflict situations and the traffic flow volume and parameters of road (width, direction, speed).

The aforementioned three-letter classification symbol was (in comparison with the original static method) changed ([3], [4]). The first part of the symbol (which classified conflict situation according to the type of the traffic way) is number:

- road with one traffic lane for one direction (urban area) ... 1
- road with two traffic lanes for one direction and with central reservation (urban area) ... 2
- road with two traffic lanes for one direction and without central reservation (urban area) ... 3
- road with one traffic lane for one direction (rural area) ... 4
- road with two traffic lanes for one direction and with central reservation (rural area) ... 5
- road with two traffic lanes for one direction and without central reservation (rural area) ... 6
- highway (rural area) ... 7

The second part of the classification symbol is formed by letters with subscript. This symbol classified the conflict situations in accordance with the reasons of the conflict situations. The conflict situations were divided into traffic conflicts and into conflicts, which are caused by defects of the roads.

The traffic conflicts are following (only samples) – see fig. 1:

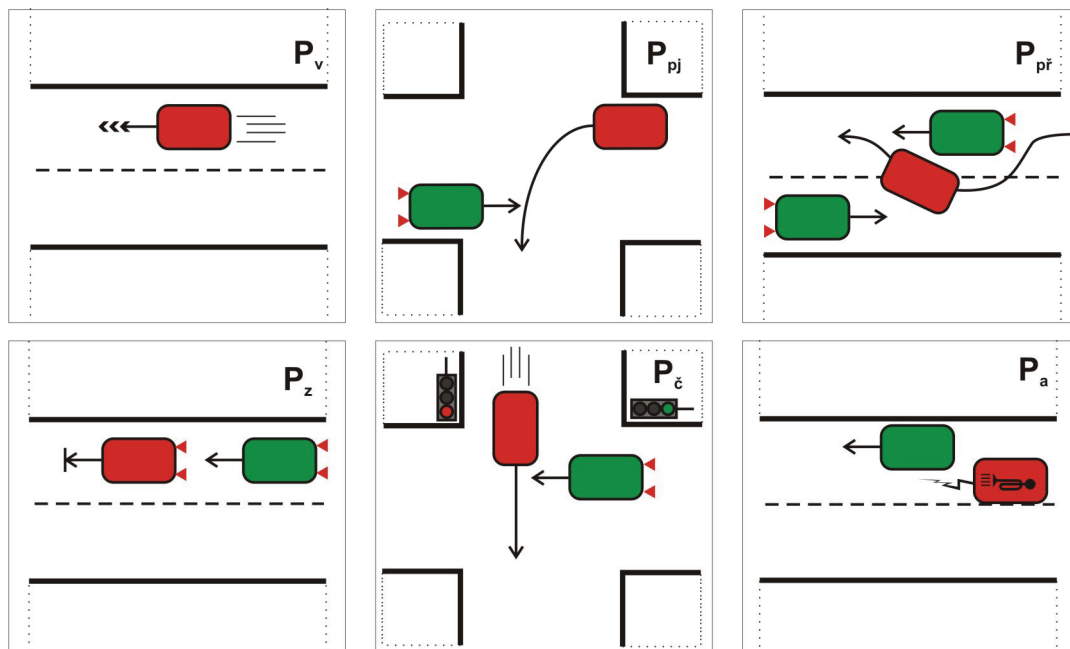
- violation of speed limit ...  $P_v$
- violation of giving way...  $P_{pj}$
- dangerous overtaking ...  $P_{pr}$
- dangerous stopping ...  $P_z$
- driving against the red light ...  $P_{\check{c}}$
- aggressiveness...  $P_a$

Conflicts, which were caused by defects of the road, are (only samples) – see fig. 2:

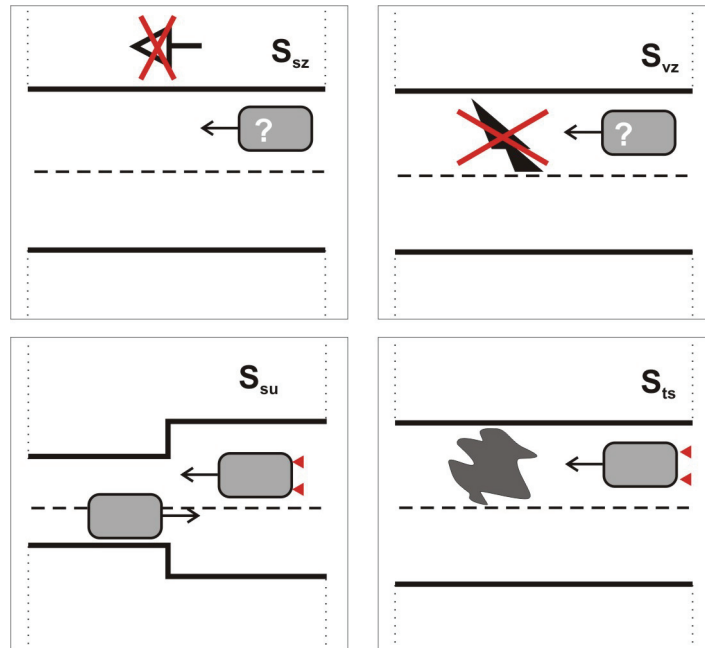
- conflict situations caused by traffic signs ...  $S_{sz}$
- conflict situations caused by road marking ...  $S_{vz}$
- conflict situations caused by construction of monitoring place ...  $S_{su}$
- conflict situations caused by technical conditions of road way ...  $S_{ts}$

The third (last) part of classification symbol is the same as the classification in the original Folprecht's video-analysis.

This method is now being developed by the Laboratory of Road Transport.



**Fig. 1** Traffic conflicts (samples)

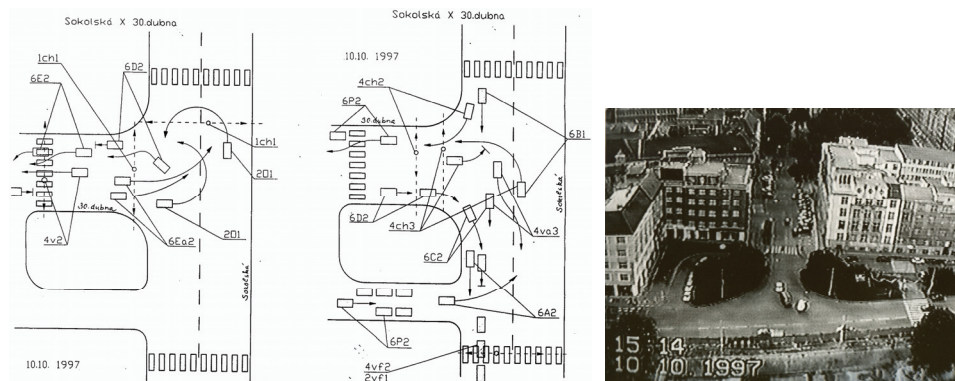


**Fig. 2** Conflicts, which were caused by defects of the road (samples)

## 6 EXAMPLES OF THE PRACTICAL CONFLICT SITUATIONS MONITORING IN THE CZECH REPUBLIC

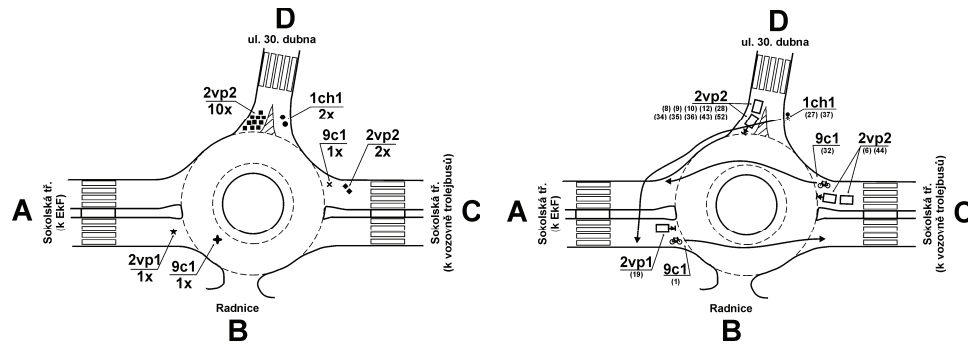
Perhaps the most monitored place of all is the intersection on the Prokeš square in Ostrava-City (intersection Sokolská-30. dubna). The main advantage was the possibility to use the near new town hall tower for video-recording.

In the 1997 (this intersection wasn't roundabout) the author of original method (author J. Folprecht) made the first measuring (see fig. 3). The coefficient of relative confliction was c. 2,5 CS/100 u.v.



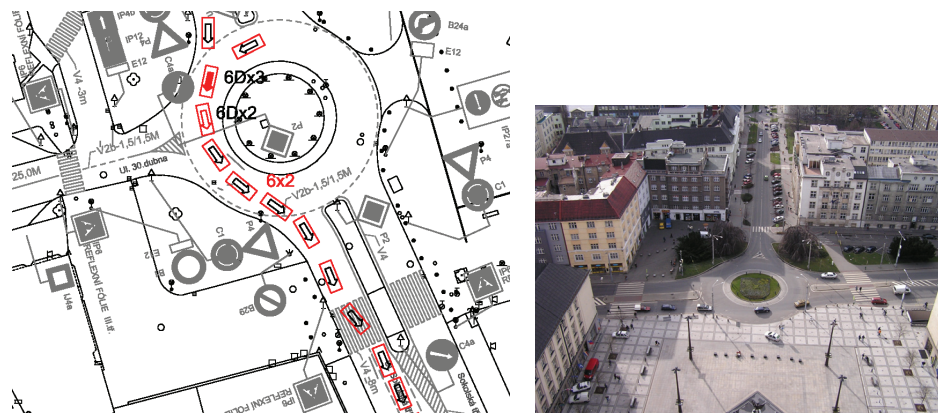
**Fig. 3** Monitoring of conflict situations on Prokeš's square (Ostrava-City, 1997)

In the 1998 this intersection was rebuilt as a small roundabout and comparative measuring took place (author V. Křivda, in 1999 and 2003) – see fig. 4. The coefficient of relative confliction was only c. 0,3 CS/100 u.v. – see [2].



**Fig. 4** Monitoring of conflict situations on the Prokeš square (Ostrava-City, 1999 and 2003)

The last measuring was carried out in the 2006 and 2007 (authors V. Křivda and L. Šíma) – see fig. 5. The coefficient of relative confliction was c. 5,0 CS/100 u.v. However, those conflict situations were mostly secondary situations (i.e., they were caused by other intersection with traffic lights).



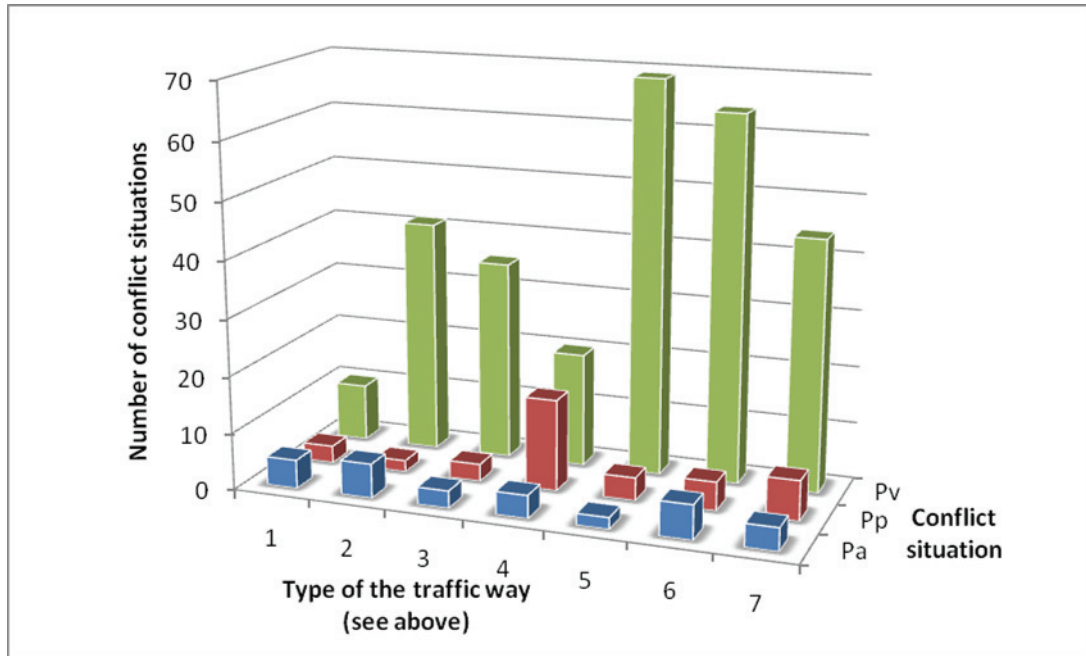
**Fig. 5** Monitoring of the conflict situations on Prokeš's square (Ostrava-City, 2006 and 2007)

The next examples of the monitored places, where the Folprecht's video-analysis has been used (recent years):

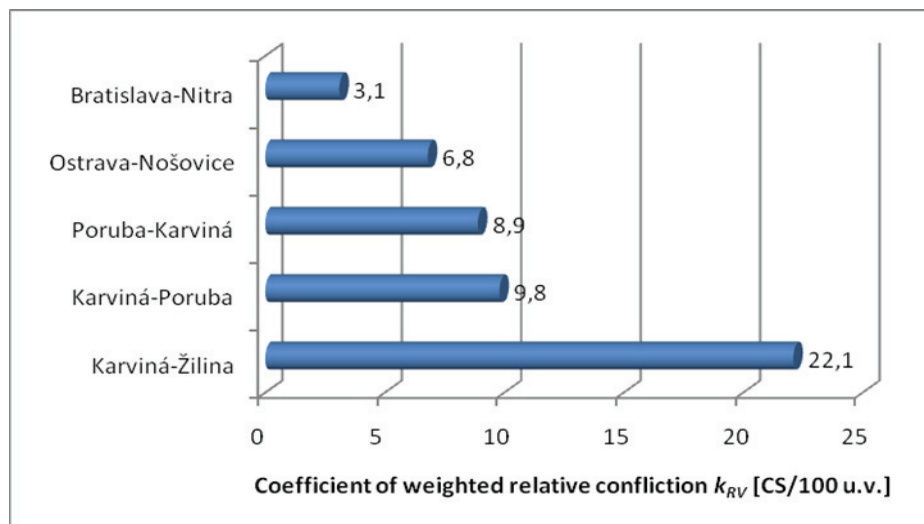
- intersection Nádražní-Mariánskohorská, Ostrava
- intersection Sokolská-Českobratrská, Ostrava
- Českobratrská street in the part from Nádražní street to Sokolská street, Ostrava
- intersection Výškovická-Čujkovická-Volgogradská, Ostrava
- intersection Jejkovského brána-Smíla Osovského-Bedřicha Václavka-Soukenická, Třebíč
- road I/55 through Otrokovice-City
- intersection Hladnovská-Michálkovická-Keltičkova, Slezská Ostrava
- ul. Ostravská, part between intersections Hlavní třída-Janáčkova-Frýdlantská-Ostravská and J. Opletala-Ostravská-17. listopadu, Frýdek-Místek
- intersection Slezská-Staroměstská, Frýdek-Místek
- intersection of roads I/55 and II/432 near Hodonín-City
- road I/56 through Hlučín-City, part between intersections Opavská-Ostravská-Celní and Opavská-Čs. armády
- road I/47 through Bílovec-City
- intersection Dolní-Kralická (U Rodenů), Prostějov

The progression of the dynamic method of the conflict situations monitoring (see above) was started in 2008 in Laboratory of Road Transport. Video-recording took place on the following roads of the Czech (CZ) and Slovak Republic (SK) – see fig. 6 and 7:

- Karviná (CZ) – Žilina (SK)
- Karviná-Hranice (CZ) – Ostrava-Poruba (CZ)
- Ostrava-Poruba (CZ) – Karviná-Hranice (CZ)
- Ostrava (CZ) – Nošovice (CZ)
- Bratislava (SK) – Nitra (SK)



**Fig. 6** Numbers of some conflict situations (dynamic method, 2008)



**Fig. 7** Coefficient of weighted relative conflict  $k_{RV}$  (dynamic method, 2008)



## 7 CONCLUSION

Finally it's necessary to repeat, that it's important to carry out monitoring of each problematic places in the public road system and analyzing their hidden elements, which cannot be identified from road design or from the analysis of the road accidents frequency. It's suitable to realize the conflict situations monitoring on newly build intersections, pedestrian crossings etc. Folprecht's video-analysis of conflict situations has proven to be of great help to increase road safety. Another advantage of this method is an automatic conflict situations analysis from video records.

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